FTA 27th Annual Engineers' Meeting 2011 ■ Washington, DC

Cost Estimating Best Practices

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Overview

- Oversight Procedure (OP) 33
- Estimate Review Process
- Grantee Submittals
- Case Study
- Review and Analysis
- Discussion (Q&A)

OP 33 - Capital Cost Estimate Review

- Objective:
  - FTA's objective is to assess the consistency of cost estimating information, understand its characteristics, and confirm that the estimate adequately reflects the overall project scope, the estimated quantities shown on the design documents, the anticipated market conditions, and the project schedule.

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OP 33 - Capital Cost Estimate Review

- Objective, cont.
  - The review results should help the Grantee with decisions regarding the level of cost control measures and mitigations required; in addition, the results will assist FTA with decisions regarding project advancement and funding.

OP 33 - Capital Cost Estimate Review

- Scope of Work:
  - Review of Grantee's Estimate Review Process
  - Review of Grantee's Cost Estimate
  - Proposed Approach to Reviewing the Estimate – A Sampling Plan
  - Basic Reviews
  - Specific Reviews

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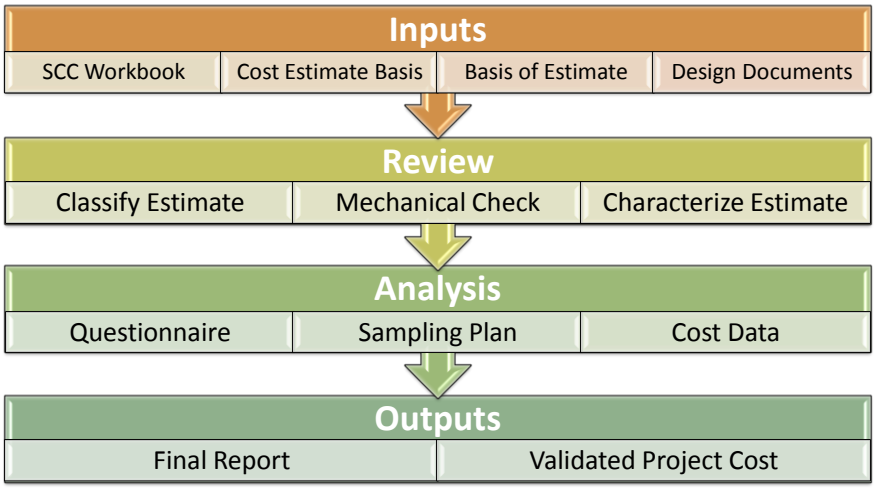
Estimate Review Process



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Grantee Submittals (Inputs)

- SCC Workbook
- Cost Estimate
- Basis of Estimate
- Project Design Documents

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SCC Workbook

MAIN WORKSHEET-BUILD ALTERNATIVE (Rev.13, June 1, 2010)

Insert Project Sponsor's Name here — Today's Date: 6/1/10

Insert Project Name and Location — Yr of Base Year $: 2010

Insert Current Phase (e.g. Applic.for PE, PE, FD, Applic.for FFGA, Construction, Rev Ops) — Yr of Revenue Ops: 2020

For all cells, round to the nearest 1,000 before inserting costs!

	Quantity	Base Year Dollars w/o Contingency (X000)	Base Year Dollars Allocated Contingency	Base Year Dollars TOTAL (X000)	Base Year Dollars Unit Cost (X000)	Base Year Dollars Percentage of Construction Cost	Base Year Dollars Percentage of Total Project Cost	YOE Dollars Total (X000)
10 GUIDEWAY & TRACK ELEMENTS (route miles)	**9.00**	**90,000**	**18,000**	**108,000**	**$ 12,000**	**44%**	**28%**	**123,881**
10.01 Guideway: At-grade exclusive right-of-way	9.00	90,000	18,000	108,000	$ 12,000			123,881
10.02 Guideway: At-grade semi-exclusive (allows cross-traffic)				0				0
10.03 Guideway: At-grade in mixed traffic				0				0
10.04 Guideway: Aerial structure				0				0
10.05 Guideway: Built-up fill				0				0
10.06 Guideway: Underground cut & cover				0				0
10.07 Guideway: Underground tunnel				0				0
10.08 Guideway: Retained cut or fill				0				0
10.09 Track: Direct fixation				0				0
10.10 Track: Embedded				0				0
10.11 Track: Ballasted				0				0
10.12 Track: Special (switches, turnouts)				0				0
10.13 Track: Vibration and noise dampening				0				0
20 STATIONS, STOPS, TERMINALS, INTERMODAL (number)	**18**	**30,000**	**6,000**	**36,000**	**$ 2,000**	**15%**	**9%**	**37,912**
20.01 At-grade station, stop, shelter, mall, terminal, platform	18	30,000	6,000	36,000	$ 2,000			37,912
20.02 Aerial station, stop, shelter, mall, terminal, platform				0				0
20.03 Underground station, stop, shelter, mall, terminal, platform				0				0
20.04 Other stations, landings, terminals: Intermodal, ferry, trolley, etc.				0				0
20.05 Joint development				0				0
20.06 Automobile parking multi-story structure				0				0
20.07 Elevators, escalators				0				0
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	**9.00**	**10,000**	**2,000**	**12,000**	**$ 1,333**	**5%**	**3%**	**12,637**

Year of Base Year Dollars should match the year in "Today's Date."

YOE Dollars automatically arrive from Inflation Worksheet.

YOE costs for individual line items within a Category are derived as a percentage of the YOE cost of the Category.

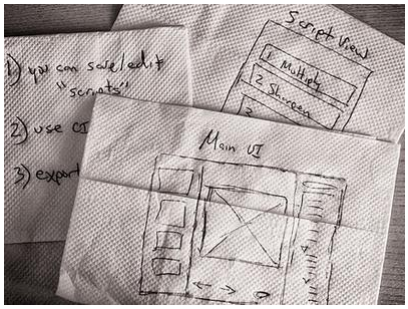
Preparing for bid:

For each separate contract package generate a Main Worksheet and an Inflation Worksheet.

In the Special Conditions of the Contract, require the construction contractor to update these worksheets and

Cost Estimate Data

Basic



Detailed

Rule of Thumb

The content and complexity of the cost estimate should reflect the development of the project.

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Types of Cost Estimates

- Parametric (Statistical)
  - A cost estimating methodology using statistical relationships
- Analogous (Comparison)
  - An estimate of costs based on historical data of a similar (analog) item.
- Bottom-Up (Detailed Engineering)
  - This involves using a detailed WBS and pricing out each work package making up the project.
- Extrapolation (Earned Value)
  - Estimates which are based on actual project costs

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Parametric Estimates

- Parametric estimates are a cost estimating methodology using statistical relationships between historical costs and other program variables such as system physical or performance characteristics, contractor output measures, or manpower loading.
- This method uses regression analysis of a database of two or more similar systems to develop cost estimating relationships (CERs)

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Analogous Estimates

- The analogy method compares a new or proposed system with one analogous (i.e., similar) system, that was typically acquired in the recent past, for which there is accurate cost and technical data. There must be a reasonable correlation between the proposed and "historical" system.
- The estimator makes a subjective evaluation of the differences between the new system of interest and the historical system.

Bottom-Up Estimates

- The engineering or "bottoms-up" method of cost analysis is the most detailed of all the techniques and the most costly to implement. It reflects a detailed build-up of labor, material and overhead costs.
- This method is often used by contractors and usually involves industrial engineers, price analysts, and cost accountants.

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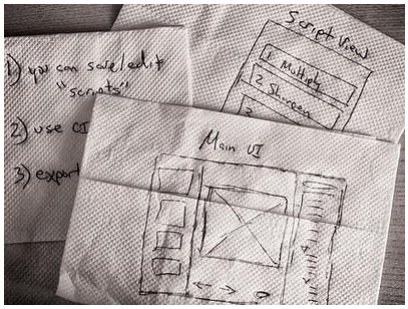
Basis of Estimate

- The FTA suggests that grantees provide a written basis of estimate (BOE) and provide a suggested format.
- The BOE document should be a thorough detailed document that communicates the inner working of the cost estimate.
- Many of the experienced grantees provide supplemental information or formal BOE report.

Design Documentation

Basic



Detailed

Rule of Thumb

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Case Study

- Case Study Assumptions
- Basis of Estimate
- Estimate Workbook

Case Study

- Assumptions
  - New Starts Project Entering PE
  - Documents provided
    - 30% Design Drawings
    - SCC workbook
    - Basis of Estimate
    - Cost Estimate in Excel workbook format
      - demonstrating the direct translation of parametric, analogous, allowance, and contingency costs from the estimate backup documents to the SCC workbook
      - Cost Estimate was 11,000 lines of data

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Case Study Basis of Estimate

- Parametric price/quantity estimating methods were used for SCC 10 through 50, covering the infrastructure and systems work.
- The unit costs for track, structures, street construction, stations and park and ride, were derived from the TRZ Consolidated project cost database.
- The TRZ Consolidated database includes cost data from 9 major light rail projects and 36 minor light rail infrastructure projects performed in the Great Plains region of the United States

Case Study Basis of Estimate

- SCC 10
  - Light rail grade construction costs include the items necessary to prepare and improve public and private (non-street) right-of-way for acceptance of the light rail double-track.
  - The costs include contractor's mobilization, clearing and grubbing, minor excavation and embankment, minor concrete work, landscaping, irrigation, sub-drainage, fences, subgrade and sub ballast within a right-of-way of approximately 32-to-50 feet in width.
  - Civil construction for power pole foundations and systems-related underground conduits, duct bank and manholes are also included, as well as major earthwork activities related to track grade construction.

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Case Study Basis of Estimate

- Assumptions Exclusions and Inclusions
  - Working conditions assumed
    - Typical regional construction seasons occur; no unusual weather conditions
    - The project followed the current project schedule (4-333.PRX)
    - Construction sites and materials are available when needed
  - Inclusions
    - Future station at Lulabelle Avenue; the estimate includes an allowance for below grade work (e.g. conduit)
    - Multi-use path at Central Park Pedestrian Bridge; the estimate includes the structural capacity to add this at a later time.
  - Exclusions
    - Project to raise profile of Johnson Street required for Johnson Street Station will be completed by others in time for construction

Case Study Estimate Workbook

Description	Quantity	UM	UnitCosts	Line Cost
Paved Single Track, Grade Prep - 6th (Jackson to Grant)	817	SY	$68.00	$55,531
Demo existing pavements for LRT grade (IB - single track)	250	SY	$30.00	$7,500
Paved Single Track, Grade Prep - 6th (Jackson to Grant)	325	LF	$137.00	$44,525
Paved Single Track, Grade Prep - 6th (Jackson to Grant)	325	LF	$333.00	$108,225
Paved Single Track, Grade Prep - 6th (Jackson to Grant)	542	SY	$11.00	$5,958
Ground fencing within specified proximity of track	5,068	LF	$11.00	$55,732
Demo existing pavements for LRT grade (OB - single track)	120	SY	$30.00	$3,600
Misc Demo existing items for LRT grade (terminus/turn-around area)	278	SY	$30.00	$8,333
Paved Single Track, Grade Prep - 5th (Jackson to Grant)	195	LF	$333.00	$64,935
Paved Single Track, Grade Prep - 5th (Jackson to Grant)	390	SY	$68.00	$26,519
Paved Single Track, Grade Prep - 5th (Jackson to Grant)	260	SY	$11.00	$2,860
Paved Single Track, Grade Prep - 6th (Jackson to Grant)	222	SY	$68.00	$15,110
Demo existing pavements for LRT grade (IB/OB - double track)	105	SY	$20.00	$2,100

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Review and Analysis

- Classify Estimate
  - Determine Estimating Method
  - Determine Estimating Effort
- Mechanical Check
  - Math and Accounting Checks
- Characterize Estimate
  - Determine Estimate Details
- Sampling Plan

Estimate Classification

- Determine the type of estimate
  - Parametric
  - Analogous
  - Bottom-Up
- Determine estimating level of effort
  - PMOC Experiential Judgment
- This information is used to develop the data sampling plan.

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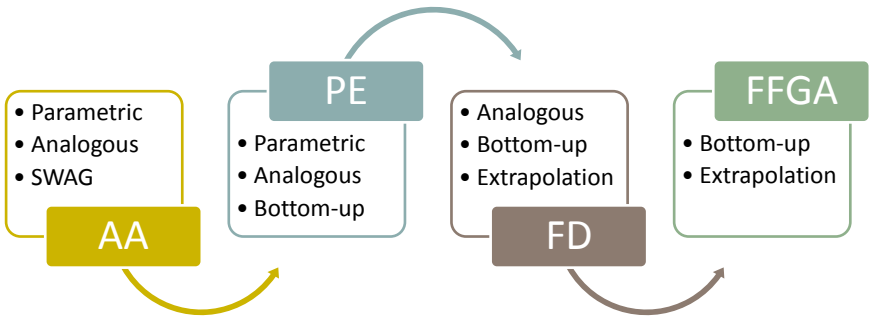
Project Phase / Estimating Method



Mechanical Correctness

- The submitted cost estimates are subjected to several mechanical tests to determine the level of accuracy.
- The mechanical check is a basic mathematical review of the dollar figures presented to determine:
  - Mathematical correctness in extended costs
  - Dollar values are transferred correctly.
  - Electronic workbooks are formulaically correct.

Estimate Characterization

- The FTA method uses a series of levels which, in essence, creates a matrix of cost sources based on the SCC.
- Vertical elements of the matrix are the traced source of the cost.
- Horizontal elements of the matrix characterize the cost estimate line items calculation methods.

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Estimate Characterization

	Bottom-up Unit Cost	Unit Cost Database	CER	Allowance	TOTAL
Drawings / Specifications					
Design Report					
Schedule (escalation)					
Contingencies					
TOTAL					

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Estimate Characterization

	Bottom-up Unit Cost	Unit Cost Database	CER	Allowance
Drawings / Specifications	Lowest Risk			
Design Report				
Schedule (escalation)				
Contingencies				Highest Risk

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Estimate Characterization

Name	Bottom Up Unit Cost	Unit Cost Database	CER	Allowance	TOTAL
SCC 10 Guideway		**$35,139,373**	**$8,806,709**	**$10,035,747**	**$53,981,828**
Drawings / Specifications					
Design Report / EIS		$26,096,306		$7,453,062	$33,549,367
Indirect Costs		$9,043,067		$2,582,685	$11,625,752
Contingencies			$8,806,709		$8,806,709
SCC 20 Stations		**$30,586,940**	**$6,058,377**	**$490,264**	**$37,135,581**
Drawings / Specifications					
Design Report / EIS		$22,715,435		$364,095	$23,079,530
Indirect Costs		$7,871,505		$126,169	$7,997,674
Contingencies			$6,058,377		$6,058,377
SCC 50 Systems			**$6,041,200**	**$26,100,606**	**$32,141,806**
Drawings / Specifications					
Design Report / EIS				$19,178,412	$19,178,412
Indirect Costs				$6,922,194	$6,922,194
Contingencies			$6,041,200		$6,041,200

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Estimate Characterization

Name	Bottom Up Unit Cost	Unit Cost Database	CER	Allowance	TOTAL
Totals	$0	$65,726,313	$20,906,286	$36,626,617	$123,259,215
Drawings / Specifications	$0	$0	$0	$0	$0
Design Report / EIS	$0	$48,811,741	$0	$26,995,569	$75,807,309
Indirect Costs	$0	$16,914,572	$0	$9,631,048	$26,545,620
Contingencies	$0	$0	$20,906,286	$0	$20,906,286

Estimate composition:

Unit Cost Database	53.3%
Cost Estimating Relationship	17.0%
Allowances	29.7%

Sources of cost elements:

Drawings / Specs	0.0%
Design Report	61.5%
Indirect Costs	21.5%
Contingencies	17.0%

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Estimate Characterization

- Overall the data from the example indicates that the cost estimate is
  - Primarily based on the design report documents;
  - drawings and specifications were not widely used in calculating the cost;
  - indirect costs were accounted for
  - the contingencies total less than 20% of the cost
  - half of the estimated costs by dollars were derived from a database

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Sampling Plan

- The PMOC develops this plan from the cost estimate classification and characterization data.
- The plan includes a description of the level of sampling of the estimate line items, and identifies the sources of costs to be reviewed including third parties, market forces, sequencing options, etc.

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Additional Observations

- Limited Data
- Determining Data Sample Size

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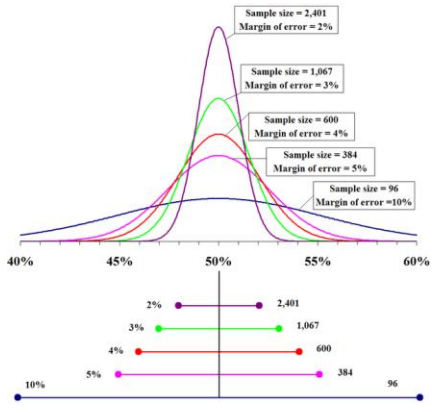
Working With Limited Data

- In some cases the grantee has a very limited database of costs that the estimators are working from.



Determining Sample Size

- Assuming sampling is random in population
  - every 5th item,
  - every 100th item,
  - drawn out of a hat
- The larger the Sample the smaller the Statistical Margin of Error

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